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(54) ENCODING AND SENSING OF SYRINGE INFORMATION

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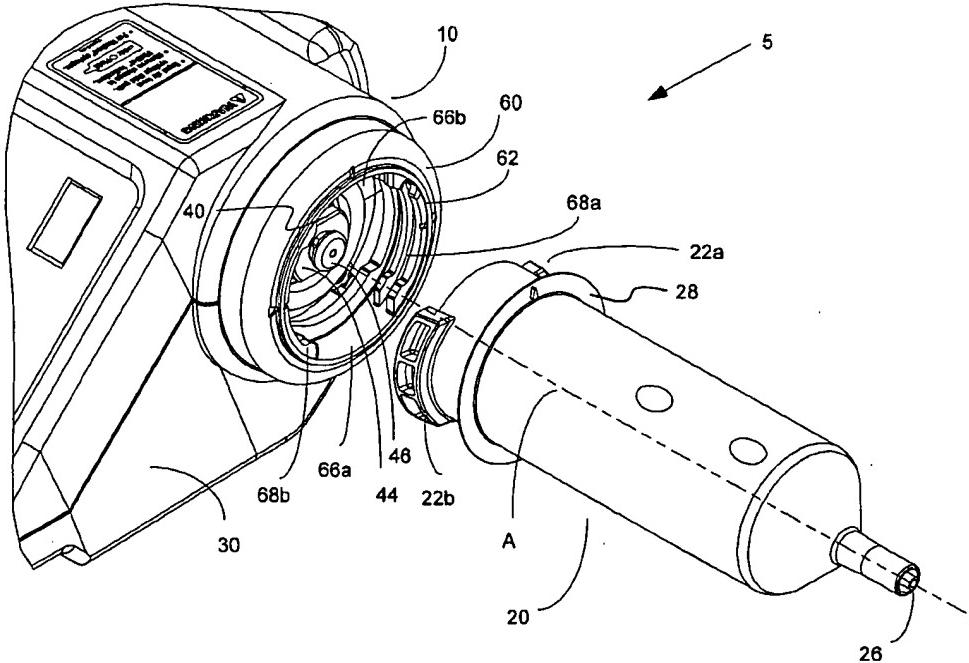
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(57) ABSTRACT

A syringe for use with a powered injector to inject a fluid into a patient includes at least a first indicator positioned on the syringe at a predetermined axial position. The distance between a rearward surface of the first indicator and a predetermined position on the powered injector provides information about the syringe configuration. The first indicator can, for example, be a rear surface of the attachment flange. An injector system includes a powered injector having a drive member and at least one sensor for detecting energy. The injector system also includes a syringe having at least a first indicator positioned on the syringe at a predetermined axial position. The energy detected by the sensor is determined by the axial position of the indicator when the syringe is attached to the powered injector. The axial position of the indicator thereby provides information about the syringe configuration.



ing mechanism to minimize or substantially prevent misreads. Misreads can occur, for example, if the entire "sweet spot" of a sensor is not blocked or unblocked with respect to a specific syringe state. In several embodiments of the present invention, Omron EE-SX1103 photomicrosensors available from Omron Electronics, Inc. of Schaumburg, Ill., were used as sensors 510a-c. Further information on these sensors is provided in the Omron Electronics, Inc. specification sheet for the EE-SX1103 photomicrosensor, the disclosure of which is incorporated herein by reference. For those sensors, the distance between the fully open and fully closed state is 0.020 in. Circuit board 500 (upon which sensors 510a-c are mounted) is adjustable in position in the direction of the movement axis of push pin 432 to facilitate alignment.

[0087] Preferably, a mechanical calibration is performed upon installation of sensor circuit board 500. In the embodiment of FIGS. 8A and 8B, for example, a calibration was performed using a slug corresponding to syringe/adapter type 1 (see Table 2) engaged on syringe interface 400 (see FIG. 7D). During the calibration, the top surface of top-most sensor 510a is aligned with the top of shutter 434 as illustrated by the arrow in FIG. 8A. This position biases the push pin/shutter assembly slightly and removed tolerances from the system. (Several remaining tolerances correspond to the flange thickness on the syringes or adapters, the sensor placement and the notch/blocking extension dimensions of shutter 434 (see FIGS. 8A and 8B)). These tolerances can contribute to the "sweet spot" of the sensor(s) moving relative to the notches/blocking extensions on shutter 434.

[0088] FIG. 8B illustrates representative misread plays (that is, the distance between a sensor sweet spot and the edge of an adjacent blocking extension 435) for a machined steel shutter assembly having the dimensions set forth in FIG. 8A. In FIG. 8B, the shutter displacement corresponds to a syringe/adapter of type 3 engaged within syringe interface 400. Distinct states are readily obtained and associated tolerances indicate that misreads should not occur. FIG. 8C illustrates test results obtained. The hatched regions between states in FIG. 8C represent transition zones in which sensors 510a-c were in the process of changing states.

[0089] The foregoing description and accompanying drawings set forth the preferred embodiments of the invention at the present time. Various modifications, additions and alternative designs will, of course, become apparent to those skilled in the art in light of the foregoing teachings without departing from the scope of the disclosed invention. The scope of the invention is indicated by the following claims rather than by the foregoing description. All changes and variations that come within the meaning and range of equivalency of the claims are to be embraced within their scope.

What is claimed is:

1. A syringe for use with a powered injector, the syringe comprising:

at least a first indicator positioned on the syringe at a predetermined position, the at least a first indicator defining a surface, the distance between the surface of the at least a first indicator and a predetermined position on the powered injector when the syringe is in

operative connection with the powered injector providing information about the syringe configuration.

2. A syringe for use with a powered injector, the syringe comprising:

a rearward projecting member on a rear portion of the syringe, an axial position of a rear surface of the rearward projecting member providing information about a syringe configuration when the syringe is attached to the powered injector; and

a positioning member operable to cooperate with the injector when the syringe is attached to the injector to position the rearward surface of the rearward projecting member at the axial position.

3. The syringe of claim 2 wherein the axial position is within a unique range of axial positions defined for the syringe configuration of the syringe.

4. The syringe of claim 3 wherein the rear surface comprises the rear surface of an attachment flange operable to attach the syringe to the injector.

5. The syringe of claim 4 wherein the positioning member comprises a flange on the syringe positioned forward of the attachment flange.

6. A set of a plurality of syringes for use with a powered injector to inject a fluid into a patient, each of the syringes comprising at least a first indicator positioned on the syringe at a predetermined position, the distance between a surface of the first indicator and a position on the powered injector when the syringe is in operative connection with the powered injector providing information about a configuration of each syringe.

7. A set of claim 6 wherein the indicator is a rearward surface of a rearward projecting member on a rear portion of each of the syringes.

8. A set of claim 7 wherein each of the syringes further comprises a positioning member operable to cooperate with the injector when the syringe is attached to the injector to position the rearward surface of the rearward projecting member at the predetermined position.

9. The set of claim 8 wherein the predetermined position of the rear surface of each syringe is within a unique range of axial positions defined for the syringe configuration of that syringe.

10. The set of claim 9 wherein the rear surface is the rear surface of an attachment flange operable to attach the syringe to the injector.

11. The set of claim 10 wherein the positioning member comprises one or more flanges on the syringe positioned forward of the attachment flange.

12. An injector system comprising:

a powered injector comprising a drive member and at least one sensor for detecting energy; and

a syringe comprising at least a first indicator positioned on the syringe at a predetermined position, the syringe configuration that is detected by the sensor is determined by the position of the at least a first indicator when the syringe is attached to the powered injector, the position of the at least a first indicator thereby providing information about the syringe configuration.

13. The injector system of claim 12 wherein a rear surface of the first indicator transmits energy to the sensor.

14. The injector system of claim 13 wherein the rear surface of the first indicator comprises an energy source to transmit energy to the sensor.
15. The injector system of claim 13 wherein the rear surface of the first indicator comprises a surface that transmits energy to the sensor by reflecting energy from an energy source to the sensor.
16. The injector system of claim 12 wherein the powered injector further comprises a contact member movably disposed in the injector, a surface in operative connection with the contact member transmitting energy to the sensor, the contact member being positioned to come into contact with the first indicator when the syringe is in operative connection with the powered injector such that the position of the surface is determined by the axial position of the first indicator.
17. The injector system of claim 16 wherein the surface is a rear surface of the contact member.
18. The injector system of claim 17 wherein the rear surface of the contact member comprises an energy source to transmit energy to the sensor.
19. The injector system of claim 17 wherein the rear surface of the contact member comprises a surface to reflect energy from an energy source to the sensor.
20. The injector system of claim 17 wherein the energy is light energy.
21. The injector system of claim 19 wherein the energy is light energy.
22. The injector system of claim 21 wherein the reflective surface of the contact member is a mirrored surface.
23. The injector system of claim 22 wherein the first indicator is a rear surface of an attachment flange on a rear portion of the syringe.
24. An injector system comprising:
- at least one syringe comprising at least a first indicator positioned on the syringe at a predetermined position, the position of the at least a first indicator being associated with information about the syringe configuration; and
 - a powered injector comprising a drive member and at least a first contact member movably disposed in the injector, the at least a first contact member is positioned to come into contact with the at least a first indicator when the syringe is attached to the powered injector such that the position of the at least a first contact member is determined by the position of the at least a first indicator, the amount of change in the position of the at least a first contact member as a result of contact with the at least a first indicator being associated with syringe configuration.
25. The injector system of claim 24 wherein at least three syringe configurations are associated with at least three corresponding positions of the first contact member.
26. The injector system of claim 24 wherein each syringe configuration is associated with a range of positions of the first contact member.
27. The injector system of claim 24 wherein the powered injector further comprises at least one light reflective surface in operative connection with the first contact member, the injector system further comprising a sensor to detect light reflected from the light reflective surface.
28. The injector system of claim 27 wherein the first indicator is positioned on the rear surface of an attachment flange of the syringe.
29. The injector system of claim 24 wherein the powered injector further comprises a plurality of sensors and at least a first shutter mechanism in operative connection with the first contact member, each of the sensors having an on state and an off state, the shutter mechanism comprising at least one cooperating member to cooperate with at least one of the sensors to place the sensor in an on state or an off state, the state of each of the plurality of sensors providing a digital code corresponding to information on syringe configuration.
30. The injector system of claim 29 wherein the first indicator is positioned on the rear surface of an attachment flange of the syringe.
31. The injector system of claim 29 wherein the shutter mechanism comprises a plurality of cooperating members.
32. The injector system of claim 31 wherein the sensors are optical sensors and the cooperating members are spaced opaque members operable to block transmission of light to the sensors.
33. An injector for use with a syringe comprising at least a first indicator positioned thereon, the position of the at least a first indicator being associated with syringe configuration, the injector comprising:
- a drive member; and
 - at least a first contact member movably disposed in the injector, the at least a first contact member is positioned to come into contact with the at least a first indicator when the syringe is in operative connection with the injector such that the position of the at least a first contact member is determined by the position of the at least a first indicator, the amount of change in the position of the at least a first contact member as a result of contact with the at least a first indicator being associated with syringe configuration.
34. The injector of claim 33 wherein at least three syringe configurations are associated with at least three corresponding positions of the first contact member.
35. The injector system of claim 33 wherein each syringe configuration is associated with a range of positions of the first contact member.
36. The injector of claim 35, further comprising at least one light reflective surface in operative connection with the first contact member, the injector system further comprising a sensor to detect light reflected from the light reflective surface, the light detected by the sensor being dependent upon the position of the first contact member.
37. The injector of claim 36 wherein the first indicator is positioned on the rear surface of an attachment flange of the syringe.
38. The injector of claim 33, further comprising a plurality of sensors and at least a first shutter mechanism in operative connection with the first contact member, each of the sensors having an on state and an off state, the shutter mechanism comprising at least one cooperating member to cooperate with at least one of the sensors to place the sensor in an on state or an off state, the state of each of the plurality of sensors providing a digital code corresponding to information on syringe configuration.
39. The injector of claim 38 wherein the first indicator is positioned on the rear surface of an attachment flange of the syringe.

40. The injector of claim 38 wherein the shutter mechanism comprises a plurality of cooperating members.

41. The injector of claim 40 wherein the sensors are optical sensors and the cooperating members are spaced opaque members operable to block transmission of light to the sensors.

42. The injector of claim 41 wherein the first indicator is positioned on the rear surface of an attachment flange of the syringe and causes the first contact member to move in an axial direction.

43. The injector of claim 42 wherein the first contact member is slidably positioned on a bushing that is rotatable about the axis of the syringe.

44. The injector of claim 43 wherein the shutter mechanism is attached to the first contact member and is rotated into cooperation with the plurality of sensor upon rotation of the bushing to attach the syringe to the injector.

45. A method of reading information of syringe configuration from a syringe for use with a powered injector, the method comprising:

positioning at least a first indicator at a predetermined position on the syringe;

transmitting energy from a position determined by the indicator to a sensor on the powered injector; and

measuring an output from the sensor and correlating the output to a state distance defined by a distance between the first indicator and a known position on the injector, the state distance providing information of the syringe configuration.

46. A method of reading information of syringe configuration from a syringe for use with a powered injector, the method comprising:

positioning at least a first indicator at a predetermined position on the syringe;

contacting the indicator with at least a first contact member movably disposed in the injector so that the position of the first contact member is determined by the position of the first indicator; and

associating the position of the contact member with syringe configuration.

47. The method of claim 46 wherein at least three different syringe configurations are associated with at least three corresponding positions of the first contact member.

48. The method of claim 47, further comprising the step of transmitting light energy from a surface in operative connection with the first contact member to a sensor, the light energy measured by the sensor corresponding to the position of the first contact member.

49. The method of claim 47 wherein a shutter mechanism in operative connection with the first contact member moves with motion of the contact member to a position that determines a state of each of a plurality of sensors having an on state and an off state, the state of each of the plurality of sensors providing a digital code corresponding to information on syringe configuration.

50. A syringe adapter for use with a powered injector, the syringe adapter comprising:

an injector attachment;

a syringe attachment; and

at least a first indicator positioned on the syringe adapter at a predetermined position, the distance between a surface of the at least a first indicator and a predetermined position on the powered injector when the syringe adapter is in operative connection with the powered injector providing information about the syringe configuration of a syringe attachable to the syringe attachment.

51. An injector system comprising:

at least one syringe comprising at least a first indicator positioned on the syringe at a predetermined position, the position of the at least a first indicator being associated with information about the syringe configuration; and

an injector comprising:

a drive member;

a plurality of sensors;

at least a first contact member movably disposed in the injector, the at least a first contact member is positioned to come into contact with the at least a first indicator when the syringe is attached to the injector such that the position of the at least a first contact member is determined by the position of the at least a first indicator; and

at least a first shutter mechanism in operative connection with the at least a first contact member, each of the sensors having an on state and an off state, the shutter mechanism comprising at least one cooperating member to cooperate with at least one of the sensors to place the sensor in an on state or an off state, the state of each of the plurality of sensors providing a digital code corresponding to information on syringe configuration.

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